32-5016-A

Instruction Manual

for

Model 3600

5½-Digit

Field-Expandable

Microprocessor-Controlled

DIGITAL MULTIMETER

OPERATING INSTRUCTIONS

General Description
Specifications
Operation
Calibration

DATA PRECISION
A DIVISION OF ANALOGIC CORPORATION

MP MASTER
MA28723

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Chapter 1
INTRODUCTION & GENERAL DESCRIPTION

1.1 GENERAL

The Data Precision Model 3600 is a microcomputer-controlled, 5½-digit, digital multimeter of very flexible performance configuration. The basic instrument provides five ranges of dc voltage measurements from ± 1 microvolt to ± 1200 volts and five ranges of 3-wire dcV ratio measurements from ± 0.000001:1 to ± 199.999:1. This minimum configuration may be upgraded, **at any time**, by **field-installable options**, to provide the additional measurement capabilities of ac voltage measurements, **AC1, AC2, AC3,** (either average-sensing or true rms sensing and display, and either ac or dc input coupling), resistance measurement, KΩ,, (6 measurement ranges and front-panel switch-selectable 2-wire or 4-wire input), high impedance ratio measurements, **HI-Z**, (true differential, >1000MΩ input impedance ratio inputs instead of the basic 3-wire ratio measurement), IEEE488 Interface, **488**, remote program/data control, **BCD**, (range and trigger control inputs and BCD data outputs), and rear-panel input connection capability, **REAR**.

The user may upgrade his Model 3600 in the field, at any time, by merely installing the appropriate plug-in pc-board assembly. The Model 3600 "grows" with the requirement of the high-precision measuring application.

1.2 FEATURES

- Front-panel selectable range scale or auto-ranging.
- Auto-ranging is microcomputer controlled to select the proper full scale range without the delay of sequencing through other ranges. Measurements on "inappropriate scales" are not displayed while autoranging is in process.
- Front panel in basic instrument is complete for all installable options.
- Error message in display advises operator if selected measurement mode is not instrumented.
- Automatic self-test routines are initiated at power-on.
- Performance accuracies are consistent with the high resolution provided by a 5½-digit display resolution.

1.3 ACCESSORIES

In addition to the options indicated in paragraph 1.3, the user may order any of the following accessories for use with any measurement configuration:

- **RMD-2:** Provides a single or dual standard 19-inch rack mount.
- **A3:** A 60-inch, low thermal EMF, input cable, 2-wire + guard.
- **HC-1:** Additional mating connector and hood for the remote control/data option. (One mating connector and hood are supplied with the option board assembly.

1.4 INSTALLING MODEL 3600 OPTION CARDS

1.4.1 General

Options that are ordered at the time of ordering the Model 3600 will be installed at the factory.

The following paragraphs contain details for field installation of an option card. Refer to the appropriate set of instructions and accompanying illustration.

1.4.2 Obtaining Access to the Main Assembly

The procedure for installing an option card begins with the removal of the Model 3600 top cover and, in some cases, the inner top shield. The first illustrated procedure, paragraph 1.4.3, is applicable to other option installations.

PARA	OPTION INSTALLATION
1.4.3	Applicable to all
1.4.4	AC1, Average-Sensing. AC-Coupled
1.4.5	AC2, True-RMS Sensing, AC-Coupled
1.4.6	AC3, True-RMS Sensing, DC-Coupled
1.4.7	KΩ, Resistance Measurement
1.4.8	Hi-Z RATIO, 4-Wire Ratio Measurement
1.4.9	BCD, Remote Program/Data
1.4.10	488, IEEE 488 Interface
1.4.11	REAR, Rear Input

1.4.3 Access to the Model 3600 Assembly

This instruction is a prerequisite for the installation of field installable options and for the subsequent recalibration of the Model 3600 DMM.

Refer to Figure 1-1.

Remove the top cover by removing 4 fastening screws (1).

This provides access to the inner assembly shield.

Remove the shield by removing the single screw (2).

Refer to the appropriate subparagraph for the particular option, and follow those instructions.

After the option card(s) are installed, replace the inner shield and the top cover.

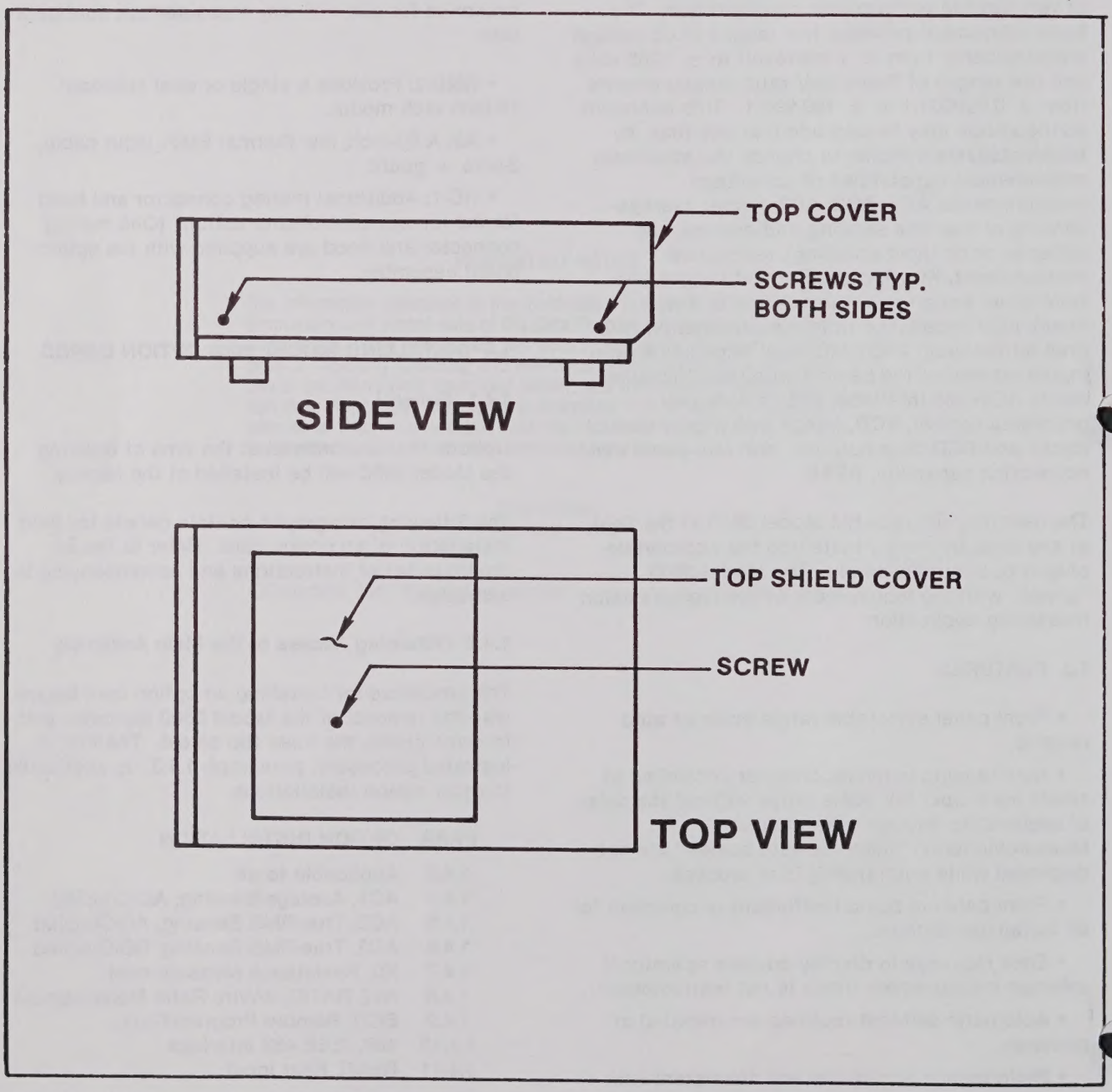


Fig. 1-1. Gaining access to the Model 3600 interior assemblies.

1.4.4 AC1: Average-Sensing, AC-Coupled ACV

Refer to Figure 1-2.

(1) Install the ac shield insulator on the inside shield wall.

(2) Plug the AC1 pc-board assembly into the Model 3600 mother board. Dress the black and green wires as shown.

(3) Plug the indicated wires into switch S10 of the mother board:

Green wire into pin 3B
Black wire into pin 6A
Coax wire into pin 6B.

Set segments 1 and 2 of switch S14 on the mother board to the **ON** position.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of shield and cover. Refer to Chapter 4 for recalibration.

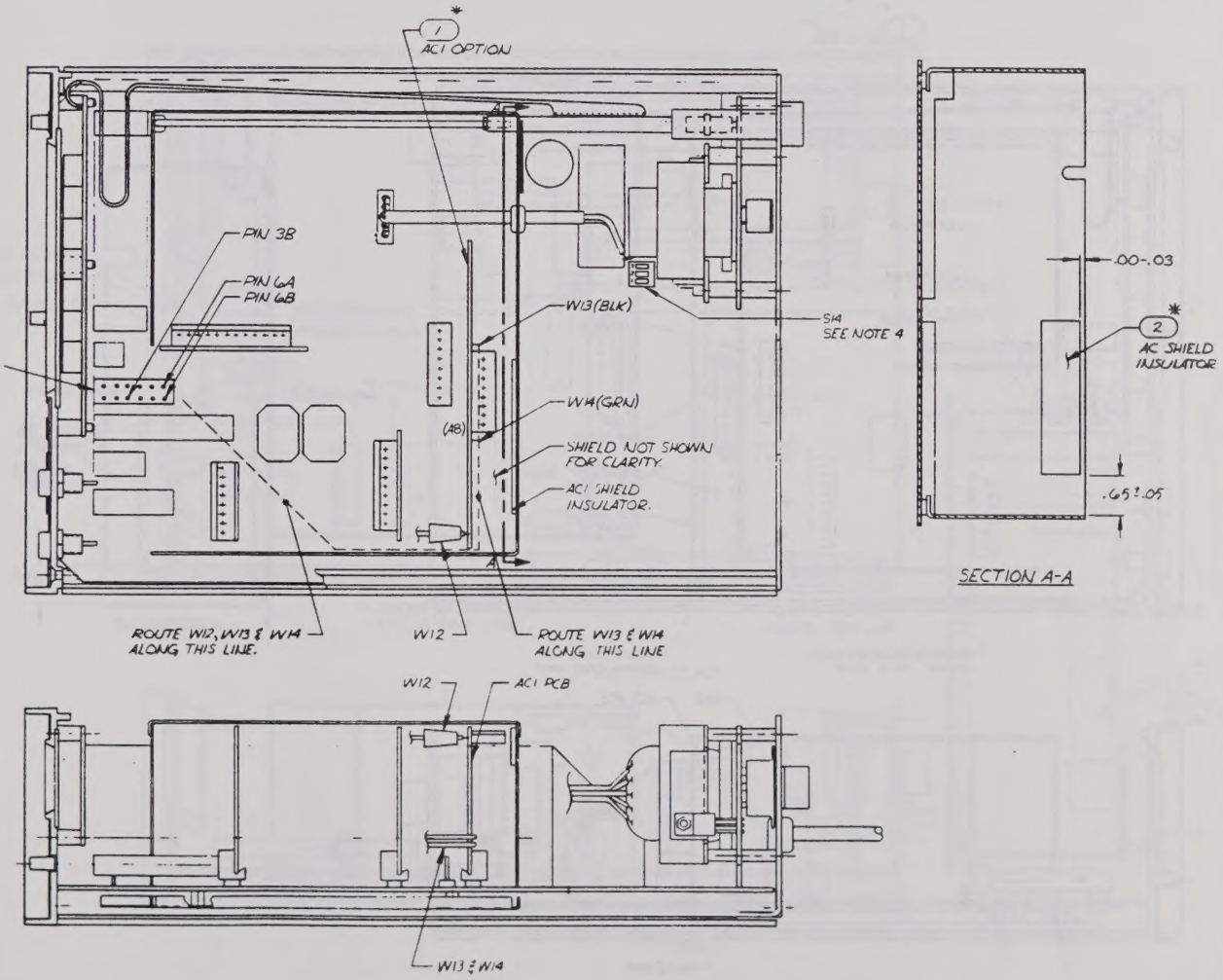


Fig. 1-2. Installing Option AC1.

1.4.5 AC2: True-RMS-Sensing, AC-Coupled ACV

Refer to Figure 1-3.

(1) Install the ac shield insulator on the inside shield wall.

(2) Plug the AC2 pc-board assembly into the Model 3600 mother board. Dress the black and green wires as shown.

(3) Plug the indicated wires into switch S10 of the mother board:

Green wire into pin 3B
Black wire into pin 6A
Coax wire into pin 6B.

Set segments 1 and 2 of switch S14 on the mother board to the **ON** position.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of shield and cover. Refer to Chapter 4 for recalibration.

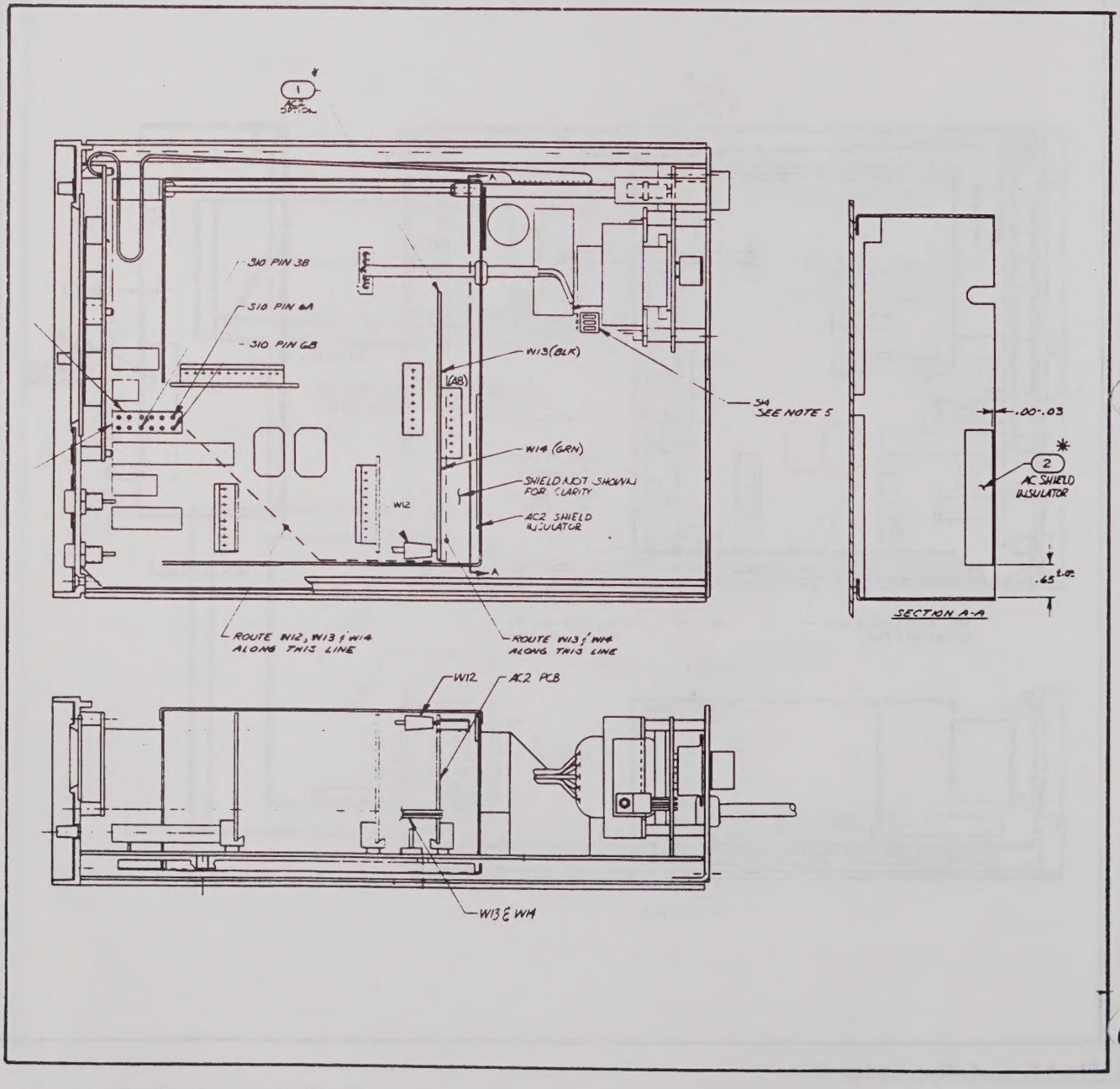


Fig. 1-3. Installing Option AC2.

1.4.6 AC3: True-RMS-Sensing, DC-Coupled ACV

Refer to Figure 1-4.

(1) Install the ac shield insulator on the inside shield wall.

(2) Plug the AC3 pc-board assembly into the Model 3600 mother board. Dress the black and green wires as shown.

(3) Plug the indicated wires into switch S10 of the mother board:

Green wire into pin 3B
Black wire into pin 6A
Coax wire into pin 6B.

Set segments 1 and 2 of switch S14 on the mother board to the **ON** position.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of shield and cover. Refer to Chapter 4 for recalibration.

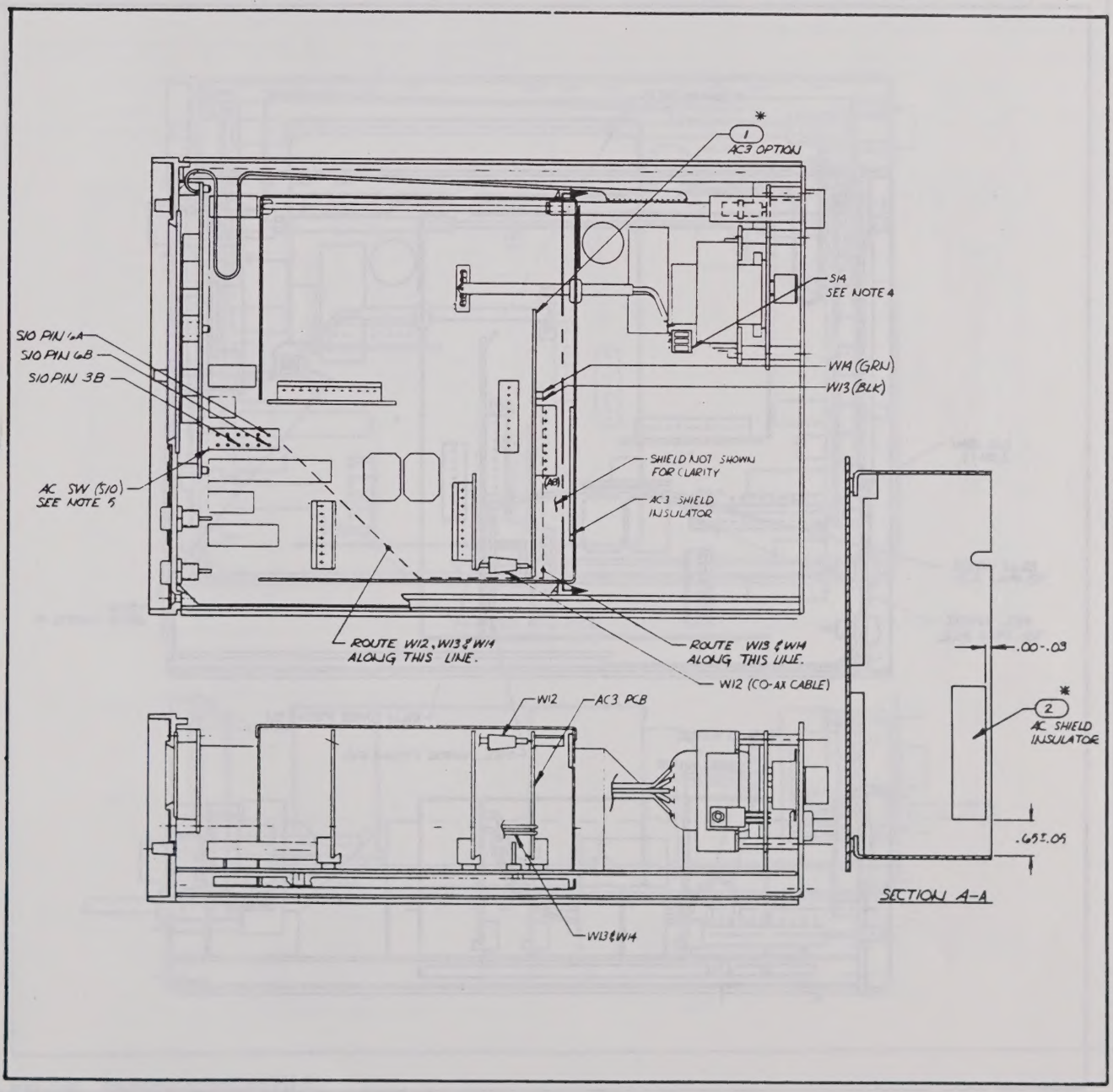


Fig. 1-4. Installing Option AC3.

1.4.7 kΩ: Resistance Measurement

Refer to Figure 1-5.

(1) Plug the kΩ pc-board assembly into the Model 3600 mother board. Dress the blue and yellow wires as shown.

(2) Plug the indicated wires into switch S11 of the mother board as shown

Blue to S11-9A
Yellow to S11-12B

Set segment 3 switch S14 on the mother board to the **ON** position.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of shield and cover. Refer to Chapter 4 for recalibration.

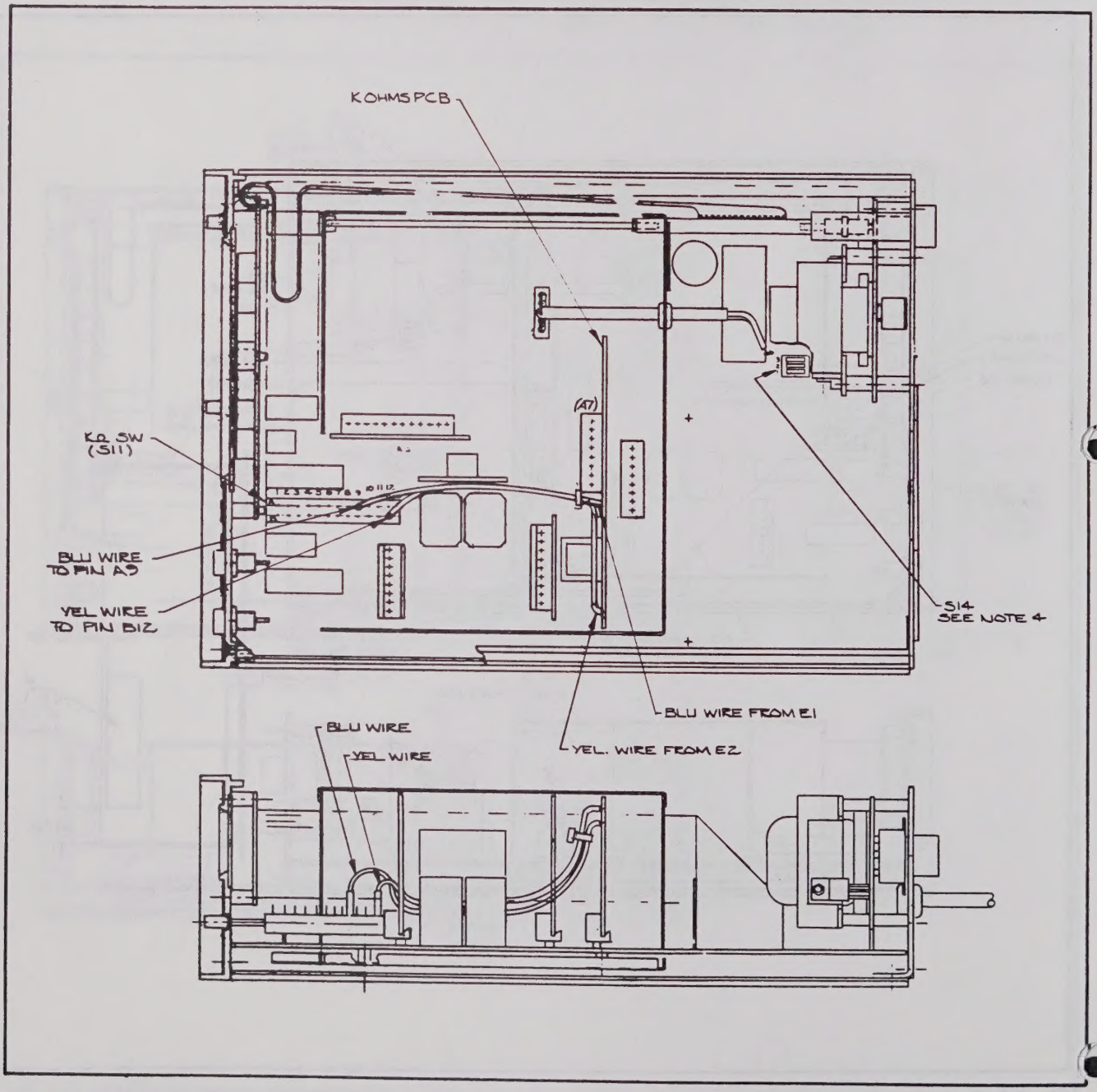


Fig. 1-5. Installing Option kΩ.

1.4.8 Hi-Z: Ratio Measurement

Refer to Figure 1-6.

(1) Unplug the basic ratio board assembly (A9).

(2) Plug the Hi-Z ratio option board in place of the removed board.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of shield and cover. Refer to Chapter 4 for recalibration.

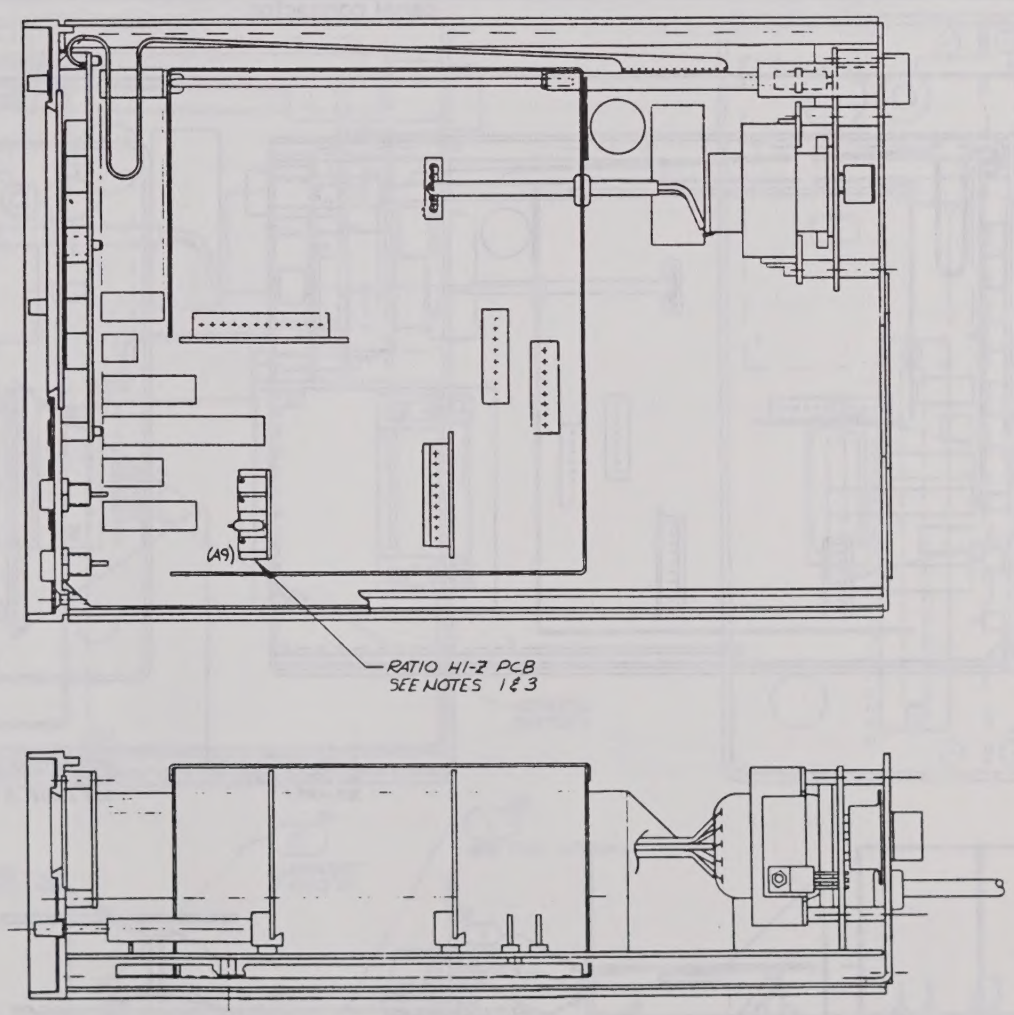


Fig. 1-6. Installing Option Hi-Z.

1.4.9 BCD: Remote Program/Data

Refer to Figure 1-7.

(1) Remove only the top cover. Refer to paragraph 1.4.3.

(2) If 488 option had been installed, remove that option assembly. Refer to its installation instructions.

(3) Remove the blank rear panel. Retain the mounting hardware for later use.

(4) Position spacer on pc-board connector P13 pins as close to pin ends as possible.

(5) Insert the BCD option card thorugh the rear panel opening, and mate P13 with J13 on the mother board.

(6) Use fastening hardware from basic rear panel to fasten the BCD option to the rear panel assembly.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of cover.
Refer to Chapter 3 for pin connections for the rear panel connector.

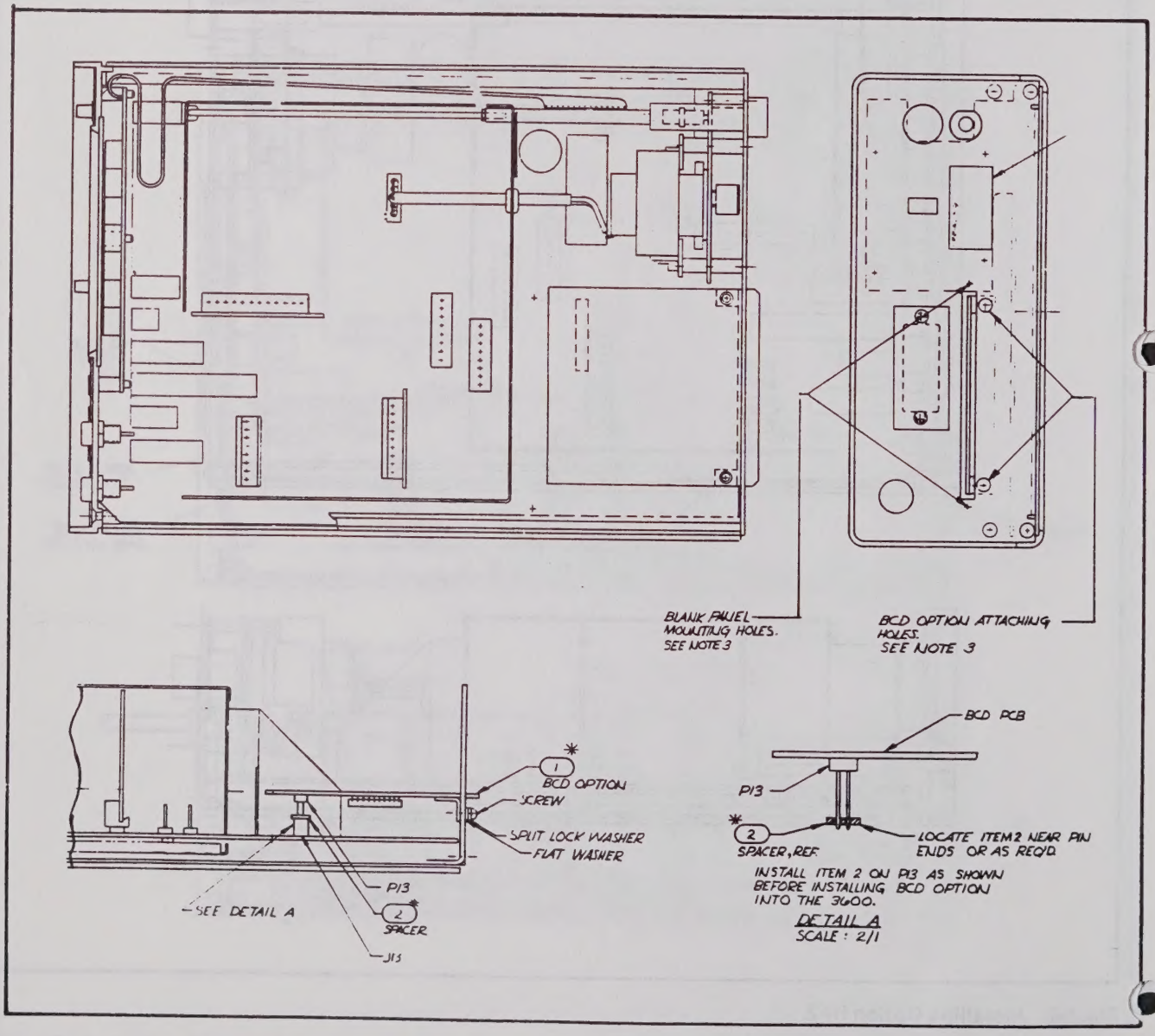

BLANK PANEL MOUNTING HOLES. SEE NOTE 3
BCD OPTION ATTACHING HOLES. SEE NOTE 3
BCD PCB
P13
2 SPACER, REF
LOCATE ITEM 2 NEAR PIN ENDS OR AS REQ'D.
INSTALL ITEM 2 ON P13 AS SHOWN BEFORE INSTALLING BCD OPTION INTO THE 3600.
DETAIL A
SCALE : 2/1
1 BCD OPTION SCREW
SPLIT LOCK WASHER
FLAT WASHER
SEE DETAIL A
P13
2 SPACER
J13

Fig. 1-7. Installing Option BCD.

1.4.10 488: IEEE488 Interface

Refer to Figure 1-8.

(1) Remove only the top cover. Refer to paragraph 1.4.3.

(2) Remove the blank rear panel.

(3) Install 2 circuit board supports.

(4) Plug the option board sock into the mother board connector P12.

(5) Insert the 488 option pc-board through the rear panel opening into the circuit board supports.

(6) Install mounting studs through the rear panel.

(7) Set address switches on the 488 board assembly as required for the selected mode of 488 interfacing.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of cover.
Refer to Chapter 3 for settings of address and mode switches.

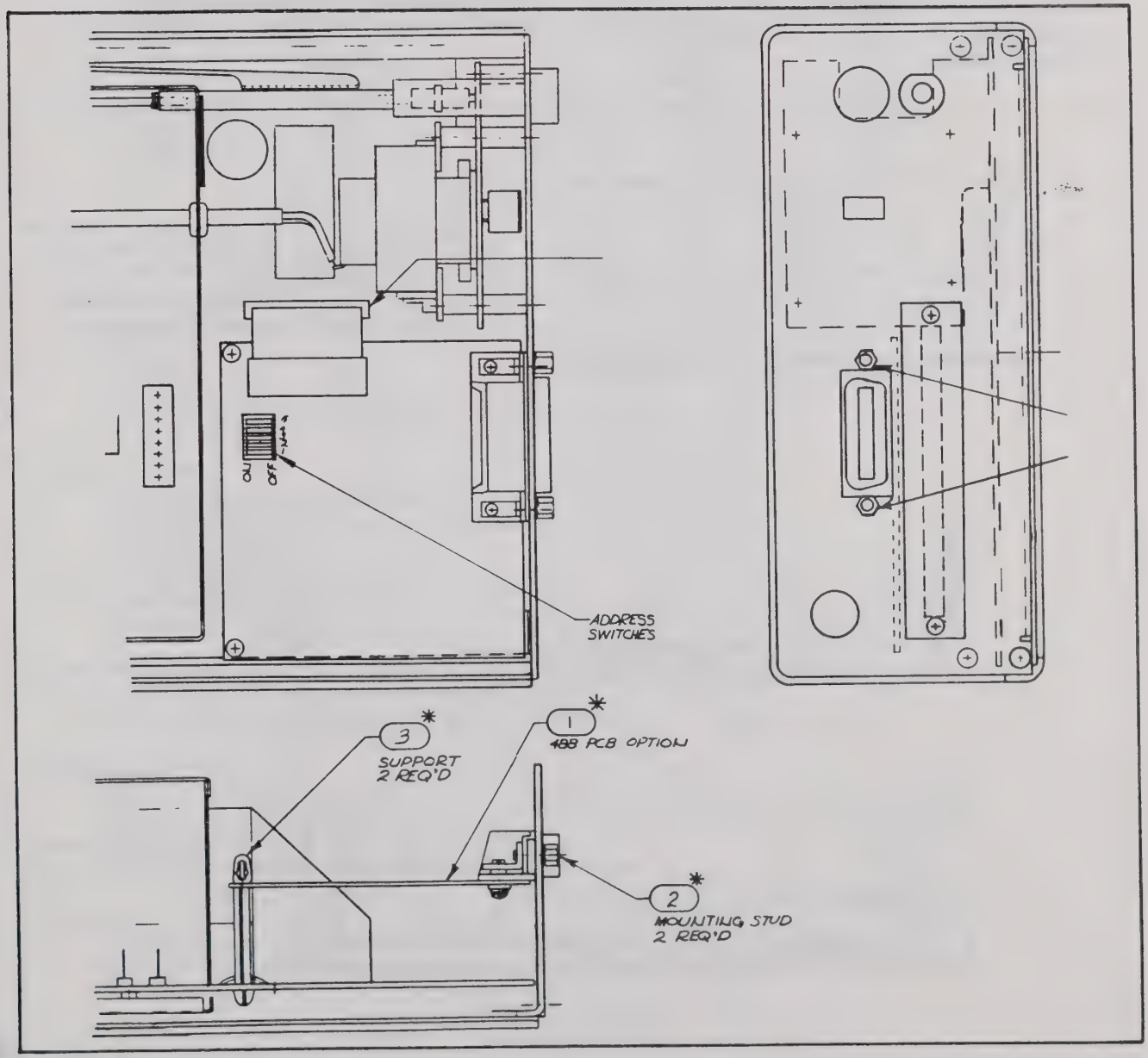


Fig. 1-8. Installing Option 488.

1.4.11 REAR: Rear Panel Input

Refer to Figure 1-9.

(1)Remove only the top cover. See instructions in paragraph 1.4.3.

(2) Remove and discard the hole plug in the basic rear panel.

(3) Solder the five wires to the front panel connectors as shown in the diagram. **Observe the color-code specifications carefully.**

(4) Install the cable retainer on the side of the DMM inner shield.

(5) Route the cable through the retainer and to the rear panel.

(6) Install the **C Ring** to fasten the rear panel connector to the panel.

(7) Connect the spare mating rear panel connector. This will keep the pins in alignment, and will protect the operator from possible shock hazard when using the front panel connectors.

The installation is complete. Refer to paragraph 1.4.3 for reassembly of shield and cover.
Refer to Chapter 4 for recalibration.

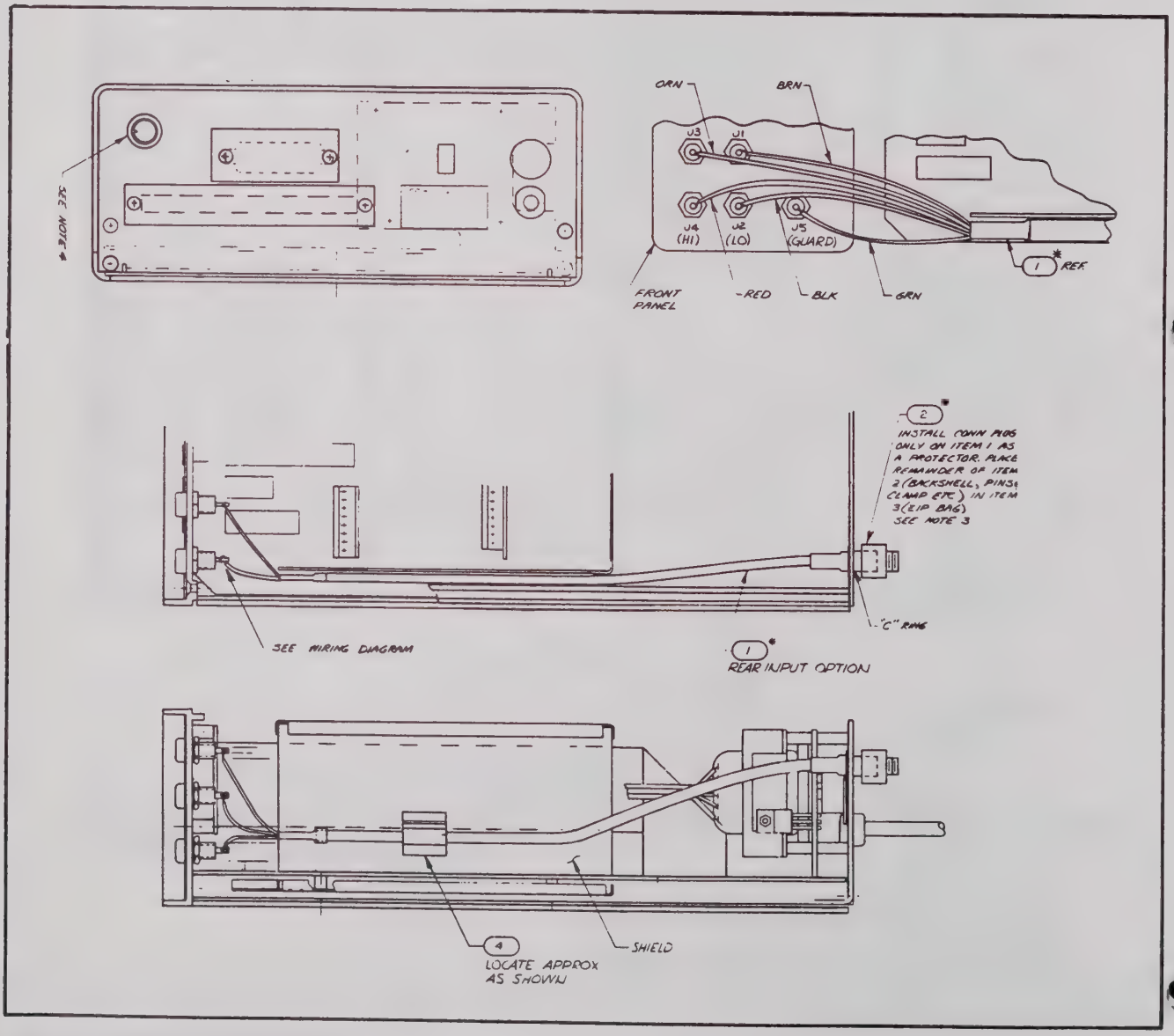


Fig. 1-9. Installing Option REAR.

Chapter 2
SPECIFICATIONS

2.1 DC VOLTS

Nominal Range	Max. Rdg.	Resolution	Input Impedance	Max Safe Voltage
± .200000	± .199999	1μV	>1000MΩ	± 1200V
± 2.00000	± 1.99999	10μV	>1000MΩ	± 1200V
± 20.0000	± 19.9999	100μV	>1000MΩ	± 1200V
± 200.000	± 199.999	1mV	10MΩ	± 1200V
± 2000.00	± 1200.00	10mV	10MΩ	± 1200V

Accuracy:

4 upper ranges, including maximum reading:

24 Hr.: @ 23°C ± 1°C, ± (0.004% inp. + 2 l.s.d.)
1 Yr.: @ 23°C ± 5°C, ± (0.007% inp. + 2 l.s.d.)

.2V range:

24 Hr.: @ 23°C ± 1°C, ± (0.005% inp. + 4 l.s.d.)
1 Yr.: @ 23°C ± 5°C, ± (0.008% inp. + 4 l.s.d.)

Voltage Coefficient:

Add ± 0.000005% rdg /volt (0.05ppm)
Generally applicable only on highest range scale)

Temperature Coefficient (0°C to + 50°C):

4 upper ranges: ± (0.001% inp. + 0.2 l.s.d.)/°C
Lowest range: ± (0.001% inp. + 0.5 l.s.d.)/°C

Common Mode Rejection Ratios (minimum):

at dc: 160dB with 1000Ω source impedance unbalance
at 60Hz: 120dB with 1000Ω source impedance unbalance

Common Mode Voltage:

500V dc (or peak ac) maximum

Normal Mode Rejection Ratio:

80dB at 50Hz and 60Hz, and at all 10Hz-increments above

Protection:

± 1200V dc or ac peak on all ranges with no damage, even while changing ranges.

2.2 AC VOLTS (Average Sensing, AC-Coupled) (Option AC1)

Nominal Range	Max. Rdg.	Resolution
.200000	.199999	1μV
2.00000	1.99999	10μV
20.0000	19.9999	100μV
200.000	199.999	1mV
2000.00*	800.00*	10mV

*See maximum voltage limitation below.

Input Impedance, all ranges:
1 MΩ ‖ < 100pF

Accuracy (1 year @ 23°C ± 5°C):

	Four Upper Ranges	.2V Range
@ 20Hz	: ± (0.5% inp. + 20 l.s.d.)	± (0.5% inp. + 100 l.s.d.)
50Hz - 1 kHz:	± (0.05% inp. + 10 l.s.d.)	± (0.05% inp. + 100 l.s.d.)
@ 10kHz:	± (0.2% inp. + 20 l.s.d.)	± (0.2% inp. + 200 l.s.d.)
@ 100kHz:	± (1% inp. + 100 l.s.d.)	± (1% inp. + 1000 l.s.d.)

Temperature Coefficient (0°C to + 50°C):

Four Upper Ranges:

20 Hz to 1 kHz	± (0.005% inp. + 2 l.s.d.)/°C
1 kHz to 10 kHz	± {(0.005% inp x freq [kHz])% rdg + 2 l.s.d.}/°C
10 kHz to 100 kHz	± (0.05% inp. + 2 l.s.d.)/°C

.2V Range:

20 Hz to 1 kHz	± (0.005% inp. + 20 l.s.d.)/°C
1 kHz to 10 kHz	± {(0.005% inp x freq [kHz])% rdg + 20 l.s.d.}/°C
10 kHz to 100kHz	± (0.05% inp. + 20 l.s.d.)/°C

Common Mode Rejection Ratio:
60dB at 60 Hz.

Maximum Input Voltage (sinewave, rms):

20 Hz to 10kHz	800V
Above 10 kHz	Linear decrease to 100V at 100kHz.

Settling Time:
2.5 seconds to within ± 0.05% of full step input.

Protection:
800V rms on all ranges with no damage, even while changing ranges.

Voltage Coefficient:
Add ± ½ ppm/volt

2.3 AC VOLTS (True-RMS Sensing, AC-Coupled) (Option AC2)

Nominal Range	Max. Rdg.	Resolution
.200000	.199999	1μV
2.00000	1.99999	10μV
20.0000	19.9999	100μV
200.000	199.999	1mV
2000.00*	800.00*	10mV

*See maximum voltage limitation below.

Input Impedance, all ranges:
1 MΩ || <100pF

Accuracy (1 year @ 23°C ± 5°C) Crest Factor ≤2. See Note 2

	Four Upper Ranges (and V_{IN} ≥1000 l.s.d.),	.2V Range (and V_{IN} ≥10,000 l.s.d.)
@20Hz	± (0.5%inp. + 50 l.s.d.)	± (0.5%inp. + 500 l.s.d.)
50Hz - 1 kHz:	± (0.15%inp. + 50 l.s.d.)	± (0.15%inp. + 500 l.s.d.)
1kHz - 10kHz:	± (0.4%inp. + 200 l.s.d.)	± (0.4% inp. + 2000 l.s.d.)
10kHz - 100kHz:	± (2% inp. + 500 l.s.d.)	± (2%inp. + 5000 l.s.d.)

Note 1: For V_{IN} ≤1000 l.s.d., 20 Hz to 10kHz Accuracy is ± 100 l.s.d.
Note 2: For Crest Factor = 3, add ± 0.4%inp from 20Hz - 10kHz
For Crest Factor = 4, add ± 0.9%inp, from 20Hz -10kHz.

Temperature Coefficient (0°C to + 50°C):

Four Upper Ranges:

20 Hz to 1 kHz	± (0.015% inp. + 10 l.s.d.)/°C
1 kHz to 10 kHz	± (0.05% inp + 30 l.s.d.)/°C
10 kHz to 100 kHz	± (0.1% inp. + 50 l.s.d.)/°C

.2V Range:

20 Hz to 1 kHz	± (0.015% inp. + 100 l.s.d.)/°C
1 kHz to 10 kHz	± (0.05% inp + 300 l.s.d.)/°C
10 kHz to 100kHz	± (0.1% inp. + 500 l.s.d.)/°C

Common Mode Rejection Ratio:
60dB at 60 Hz.

Settling Time:
<2.5 seconds

Useable Crest Factor:
7 @ ½ Full Scale
Decreasing to 3.5 @ Full Scale

Maximum Input Voltage:

30 Hz to 10kHz	300V rms sinewave
Above 10 kHz	Linear decrease to 100V rms sinewave at 100kHz.
Peak Voltage	1150 volts
DC voltage	300V

2.4 AC VOLTS (True-RMS Sensing, DC-Coupled) (Option AC3)

Nominal Range	Max. Rdg.	Resolution
.200000	.199999	1μV
2.00000	1.99999	10μV
20.0000	19.9999	100μV
200.000	199.999	1mV
2000.00*	800.00*	10mV

*See maximum voltage limitation below.

Input Impedance, all ranges:
1 MΩ ‖ < 100pF

Accuracy (1 year @ 23°C ± 5°C) Crest Factor ≤3. See Note 1

Four Upper Ranges

@20Hz :	± (1%inp. + 500 l.s.d.)
DC or 50Hz - 1 kHz:	± (0.4%inp. + 300 l.s.d.)
5kHz - 20kHz:	± (1%inp. + 300 l.s.d.)$_2$

.2V Range

@20Hz:	± (1% inp. + 5000 l.s.d.)
DC or 50Hz - 1 kHz:	± (0.4%inp. + 3000 l.s.d.)
5kHz - 20 kHz:	± (1% inp. + 3000 l.s.d.)$_3$

Note 1: For Crest Factor = 4, add ± 0.2%inp from 50Hz - 1kHz
For Crest Factor = 5, add ± 0.5%inp from 50Hz - 1kHz.
Note 2: Valid for V_{IN} > 5000 l.s.d.
Note 3: Valid for V_{IN} > 50mV rms

Temperature Coefficient (0°C to + 50°C):

Four Upper Ranges:

DC or 20 Hz to 1 kHz	± (0.015% inp. + 15 l.s.d.)/°C
1 kHz to 10 kHz	± (0.05% inp + 30 l.s.d.)/°C
10 kHz to 20 kHz	± (0.1% inp. + 50 l.s.d.)/°C

.2V Range:

DC or 20 Hz to 1 kHz	± (0.015% inp. + 150 l.s.d.)/°C
1 kHz to 10 kHz	± (0.05% inp + 300 l.s.d.)/°C
10 kHz-20kHz	± (0.1% inp. + 500 l.s.d.)/°C

Common Mode Rejection Ratio:
60dB at 60 Hz.

Settling Time:
2.5 seconds

Useable Crest Factor:
7 @ ½ Full Scale
Decreasing to 3.5 @ Full Scale

Maximum Input Voltage:

DC to 10kHz	800V rms sinewave
Above 10 kHz	Linear decrease to 500V rms sinewave at 20kHz.
Peak Voltage	1150 volts

2.5 OHMS (KΩ Option)

Nominal Range	Max. Rdg.	Resolution	Test Current
.200000kΩ	.199999kΩ	1Ω	1mA
2.00000kΩ	1.99999kΩ	10mΩ	1mA
20.0000kΩ	19.9999kΩ	100mΩ	100μA
200.000kΩ	199.999kΩ	1Ω	10μA
2000.00kΩ	1999.99kΩ	10Ω	1μA
20000.0kΩ	19999.9kΩ	100Ω	½μA

Configuration:
True 4-wire, or 2-wire, switch selected

Maximum Open Circuit Voltage:
5 volts (15V on 20,000K)

Accuracy (1Year, 23°C ± 5°C) 4-wire
2-Wire: Add 0.05Ω at front panel terminals
Add 0.25Ω at rear panel input

Selected Range(s)	Accuracy
.2kΩ	± (0.008%inp. + 4 l.s.d.)
2kΩ/20kΩ/200kΩ	± (0.007%inp. + 2 l.s.d.)
2000kΩ	± (0.02% inp. + 3 l.s.d.)
20,000kΩ	± (0.05%inp. + 3 l.s.d.)

Temperature Coefficient (0°C to + 50°C):

Selected Range(s)	Coefficient
.2kΩ	± (0.001% inp. + 1 l.s.d.)/°C
2kΩ/20kΩ/200kΩ	± (0.001% + 0.2 l.s.d.)/°C
2000kΩ	± (0.005% inp. + 1 l.s.d.)/°C
20,000kΩ	± (0.005% inp. + 1 l.s.d.)/°C

Settling Time (seconds):
0.1 + (0.3 x resistance in megohms) to within
± 0.01% final value

Maximum Input Fault Voltage:
250V rms, 350V peak, without damage

2.6 RATIO (3 Wire)

When **RATIO** is selected, the Model 3600 reads the ratio of either a dc voltage or an ac voltage connected to the input terminals (as selected by the appropriate function switch) to the dc voltage supplied at the ratio input terminals. Any of the 5 ranges (or autorange) may be used for the display. The display reads 10 times the actual ratio in volts/volt.

Displayed Reading = $10 \times (V_{IN}/V_{RATIO})$.

Ratio Voltage Range:
+ 1 to + 11
Ratio LO internally connected to Input LO

Ratio Voltage Input Resistance:
100kΩ

Accuracy
$\{$(Input Voltage Accuracy*) x 10$\}$ /V_{RATIO}.

*As specified for the selected input voltage range and function.

2.7 Hi-Z RATIO (4 Wire)

This option replaces the standard 3-wire ratio and provides true differential, high impedance, ratio inputs. Ratio HI must be 1 to 11 volts more positive than Ratio LO, and neither Ratio HI nor Ratio LO may be more than ± 12 volts from Input LO.

Displayed Reading = $10 \times (V_{IN}/V_{RATIO})$.

Input Impedance:
>1000MΩ, differential or common mode.

Accuracy (1 year, 23°C ± 5°C):
$\{$(+ Input voltage accuracy* ± 0.005% inp.) x10$\}$ /V_{RATIO}

Temperature Coefficient:
$\{$(± Input voltage T.C.* ± 0.001% inp./°C) x 10$\}$ /V_{RATIO}

*As specified for the selected input voltage range and function.

2.8 IEEE488 INTERFACE (Option 488)

This option provides a talker/listener that implements the following IEEE STD-488 Function Subsets:

T5	Basic Talker, talk only, unaddress if MLA
TE0	No extended talker
SH1	Source handshake
L4	Basic listener, unaddress if MTA
LE0	No extended listener
AH1	Acceptor handshake
SR0	No service request or serial poll capability
PP0	No parallel poll capability
DC0	No device clear
DT1	Device trigger on GET
RL0	No remote/local (partial control via addressed device dependent commands)
C0	No controller function

The Bus Address of the Model 3600 is selected via PIP switches on the option card; talk only is selected with a jumper.

Addressed commands consist of the ASCII characters 0 through 9 (parity is ignored), as follows:

0	Use local range and trigger (Clears bus trigger hold)
1	0.2V or 0.2kΩ range
2	2V or 2kΩ range
3	20V or 20kΩ range
4	200V or 200kΩ range
5	1000V or 2000kΩ range
6	20,000kΩ range
7	Autorange
8	Clears bus trigger hold
9	Sets bus trigger hold

Range changes are performed at the end of any conversion in process. "Trigger hold" holds internal triggers only; either **GET**(Group Execute Trigger) or trigger via **REMOTE PROGRAM/DATA OPTION** will initiate a conversion.

Output (TALK) Format:

D + 0.12345E + 2 CR LF

Leading Letter: D = DCV; A = ACV; K = kΩ
Sign
First Digit: 0 or 1 on scale, 9 if out-of-range
Decimal Point
5 digits of data (non-numeric if out-of-range)
E
Sign } Exponent depending on range
Digit }
CR: Carriage Return
LF: Line Feed

Note: END(EOI) is not sent at termination of string.

2.9 REMOTE PROGRAM/DATA (BCD Option)

This option provides range and trigger control inputs and parallel BCD data and status outputs for the Model 3600. Connections are made via a 44-pin card edge with a mating hood (supplied). Terminal connections are compatible with Data Precision Model 3500, and include the following:

Data Outputs

21 lines for 5 BCD digits and 1 MSD, positive true
Sign
Out-of-Range
Sign not valid (ac or kΩ)
6 lines, one for each range, negative true

Status Outputs

Integrate unknown
Ready (to be triggered)
Converting (EOC indicated by falling edge)
Data Valid (beginning with rising edge)

Inputs

6 lines, 1 per range, active LO with internal 15kΩ pullup
Autorange is selected by leaving all lines open or tied to high.
Front panel or 488 bus range selection overrides these inputs.
(Hold Internal Trigger) ; active Lo with internal 15kΩ
Trigger; maximum of 3/sec, ignored if not ready.

All outputs will drive a minimum of 4TTL loads, and are fully TTL/LSTTL compatible. Pullup resistors may be required for some CMOS applications.

All inputs are full TTL/LSTTL/5V CMOS compatible.

2.10 REAR INPUT OPTION

This option provides a rear panel input wired in parallel with the front panel. The conector is a Viking, Type TKR07, and a mating connector is supplied, Data Precision Part #25-32002.

Rear Input Pinout:

HI	**Pin 4**
LO	**Pin 2**
I+	**Pin5**
I–	**Pin 7**
GUARD	**Pin 1**
NOT USED	**Pins 3, 6**

Accuracy:
Add 0.25Ω to 2-wire kΩ accuracy
Add 50pF to ac input impedance

Note: This option requires soldering for installation. Factory installation is recommended. Recalibration after installation is recommended.

2.11 GENERAL CHARACTERISTICS

Range Selection:
7 pushbutton switches
1 per range , plus autorange

Mode Selection:
5 pushbutton switches
DCV, ACV, kΩ, 2W/4W, RATIO

Display:
5½ digit, 0.43" high LED

Power:
105-125V/210-250V
50-400Hz
15W
Model 3600J: 90-110V

Environment:
0°C to 50°C operating termperature
-25°C to 80°C storage temperatue
95% RH max, non condensing up to 40°C
80% RH max, non condensing above 40°C

Chapter 3
OPERATION

3.1 GENERAL, SCOPE OF CHAPTER

Chapter 3 contains instructions for operating Model 3600 DMM via front-panel pushbutton controls. The chapter also includes instructions for front-panel connections of the input unknown, as well as step-by-step procedures for completeing the measurement and display of the digitized information. Chapter 4 contains instructions for installing and operating the Model 3600 with the **REMOTE PROGRAM/DATA** option, while Chapter 5 contains instructions for installing and operating the Model 3600 DMM in conjunction with the **IEEE 488 Interface** Option. Attempts to complete measurements that are not supported by the appropriate installed option will result in an **Err** display message.

3.2 FRONT PANEL CONTROLS & INDICATORS

Figure 3-1 is a line drawing of th front panel of the Model 3600 DMM, in which the essential elements are referenced by their functional groups: *Power, Range, Measurement Mode, Input Connections, and Display*.

Table 3-1 describes these identified elements, and provides an introduction to their use in the normal operation of the instrument. It should be noted that the keyboard is not "locked out" when a particular option card may not be installed. Instead, as described above,the μComputer control does not process invalid commands.

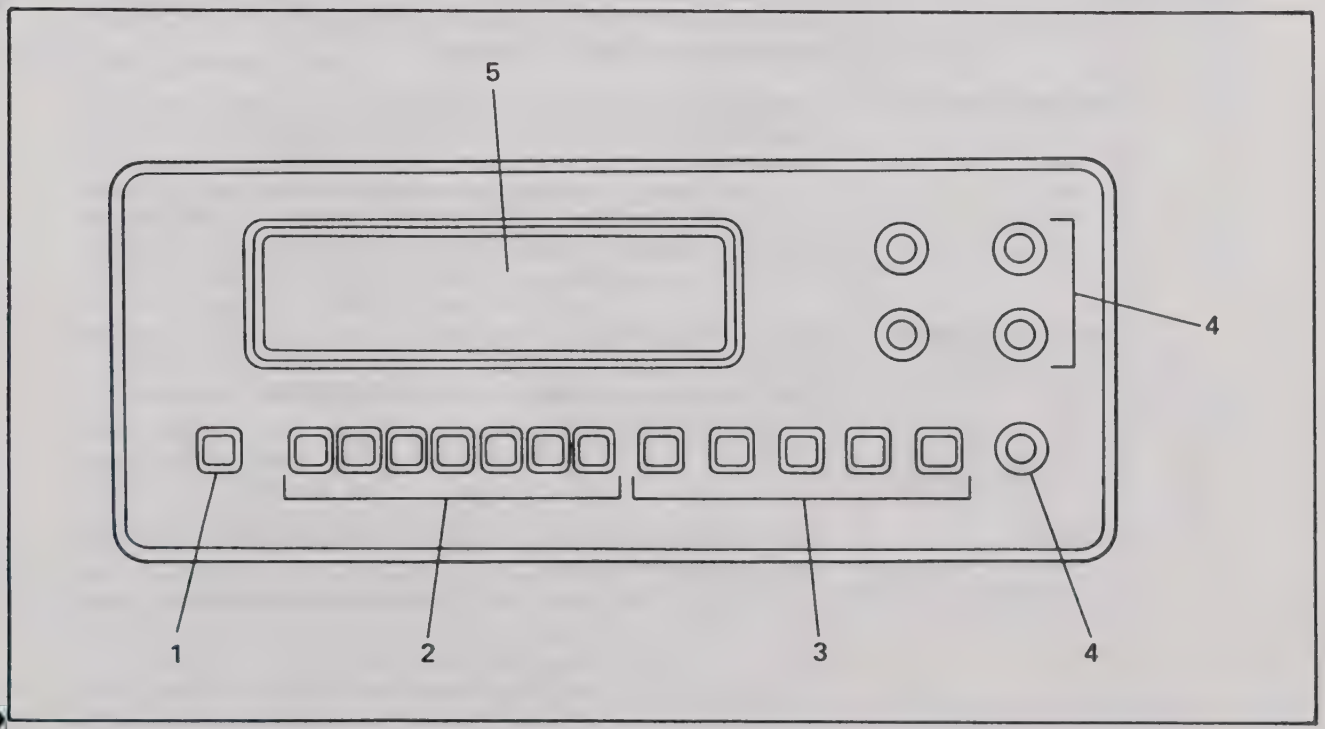


Fig. 3-1. Model 3600 Front Panel Controls and Indicators.

Table 3-1
Model 3600 DMM Front-Panel Controls & Indicators

FIG REF	NAME	DESCRIPTION/FUNCTION
1	Power Switch	Push-push switch. Turns power to instrument ON and OFF with alternate actions. When power is turned ON, the μComputer control cycles the display through every possible digit, decimal point, and polarity indication as an automatic self-test function.
2	Range Switches .2 2 20 200 2000 20K	7 interlocked pushbutton switches: 5 active switches for voltage measurements and 6 for ohms measurements and 1 autorange switch. 20K range is used for kΩ measurements only (**20KkΩ**). Operation of one switch releases any other previously selected. Selection of an improper range (20K for a voltage measurement) results in an automatic internal selection of the 2000 range. Auto-ranging is accomplished by the Model 3600 DMM under μComputer control, whereby the optimum range (best resolution) is automatically selected without "cycling", and the display is inhibited until the selected range measurement is available for display. If the input is out-of-range on the selected scale (or beyond the highest scale in autorange), the message **OL,** the decimal point and the polarity sign (if appropriate) appear, a ***and no digit is displayed***.
3	Mode Switches DCV ACV kΩ RATIO	4 Measurement Mode select pushbutton switches. First 3 are interlocked so that only one at a time may remain in the depressed position; RATIO switch may be operated in conjunction with either of the voltage measurement switches. If a measurement mode is selected that is not supported by the appropriate installed option card, the Model 3600 DMM displays the error message **Err**.
4	Input Connectors HI LO I+ I– GUARD	Recessed (banana-type) input jacks. Connections for 3-wire or 4-wire resistance measurements, or for 3-wire or 4-wire ratio measurements are made within the Model 3600. No external jumper straps are used.
5	Display	5 full decade LED digits, 1 MSD, polarity sign, and 6 possible decimal point locations.

3.3 POWER CONNECTION

Model 3600 DMM is designed to be powered from either 105 to 125V or 210 to 250V, while the Model 3600J is designed for 90 to 110V ac powering. Power line frequency may be from 50 to 400 Hz. Before plugging the 3-wire power cord into the power source, check the model designation and carefully inspect the status of the power switch accessible through the rear panel of the instrument. The switch selectable powering is indicated by the appearance of **115** or **230** in the window of the slide switch.

Operate slide switch until proper voltage source value appears in the opening.

Plug in power cord.

Turn on power at front panel and allow at least ½ hour warmup in order to achieve in-spec performance.

When power switch is first turned on, the Model 3600 initiates an automatic self check of all display components. The test cycles the display, beginning with 1.99999, 1.88888, 1.77777, etc., until all digits are lighted, and then all decimal points are actuated.

Check the display during the self test to be sure that all digit segments are operating correctly,

3.4 SIGNAL CONNECTIONS

CAUTION 1

Observe applicable maximum voltage ratings for all connections. (Refer to Chapter 2, Specifications.) Failure to comply with voltage ratings may result in equipment damage or hazardous operating conditions.

CAUTION 2

Model 3600 DMM rear input connections are internally connected in parallel with the front-panel connector jacks when the rear input option is installed. Before using one set of inputs (front or rear), always check to see that incompatible connections have not been made to the other set of inputs. It is recommended that a protective non-conducting cover be placed over the front-panel jacks when the rear panel inputs are used. (Refer to the instructions for installing the rear input option.)

3.4.1 Voltage Measurement Connections

a. Connect unknown voltage high and low to the Model 3600 terminals as shown in Figure 3-2.

b. Connect the **GUARD** to the source low, if at all possible.

As an alternate, connect the **GUARD** to the source ground, or to the 3600 DMM **LO**.

c. Always connect the **GUARD** when making a measurement.

d. Operate **DCV** or **ACV** front-panel Mode switch. If an **AC Option** is not installed, the message **Err** will be displayed.

e. Operate an appropriate range switch for the anticipated unknown voltage value to provide the maximum resolution in the display (or consistent with the accuracy of the required information), or select Autorange.

f. Read the display. The dc voltage values will be displayed with the polarity sign. The ac voltage values will be displayed without sign, and the value will be displayed in volts rms, calibrated for a sinewave. The calculation is determined according to the particular ac option that is installed. That is, average-sensed, true rms including the dc component, or rms excluding the dc component. The decimal point will be positioned automatically so that the value will be direct reading in volts. If the input exceeds the maximum reading of the selected range (refer to the Specifications), the message **OL** will appear.

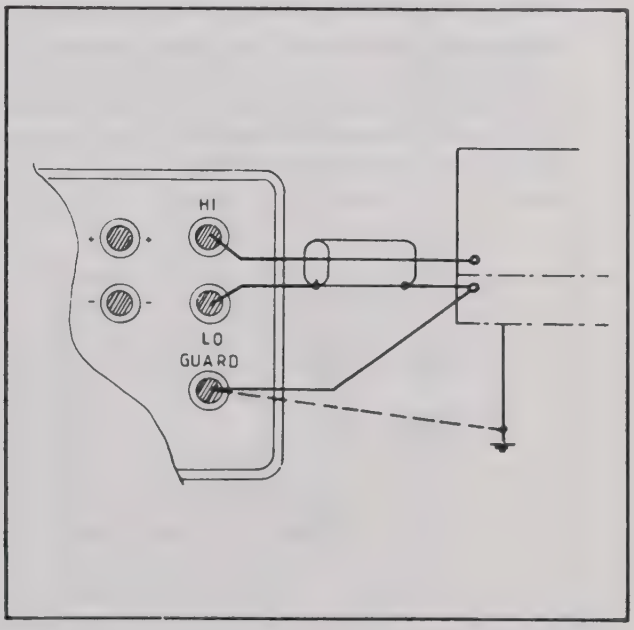


Fig. 3-2. Voltage Measurement Connections.

3.4.2 Resistance Measurement Connections

The Model 3600 DMM automatically configures the 5 front-panel jack terminals according to the selected resistance measurement mode: **2-Wire** or **4-Wire**. If the multimeter option has not been installed for the selected measurement mode, the message **Err** will be displayed.

For 2-Wire Measurements,

Connect the **HI** jack to one end ofthe resistance.

Connect the **LO** jack to the other end of the resistance.

Connect the **GUARD** jack to the resistance low side (see illustration).

For 4-Wire Measurements,

Connect sourcing current from Model 3600 **REF** terminals to the outer ends of the resista

Connect the Model 3600 **HI** and **LO** terminals to the inner ends of the resistance as in the 2-wire setup above.

Connect the **GUARD** to low side of resistance as shown in the illustration.

Select the **kΩ** measurement mode pushbutton.

Select the appropriate position of the **2-W/4-W** pushbutton

Select the appropriate range scale (**20KkΩ** may be used for the resistance measurements), or autorange.

Read the display. The decimal point is automatically positioned so that the value will be direct reading in kilohms. No polarity is displayed.

The displayed value is the resistance between the **HI** and **LO** inputs. It does not include the values of any lead resistances outside these connection points, and may therefore be used for the measurement of very low resistance values.

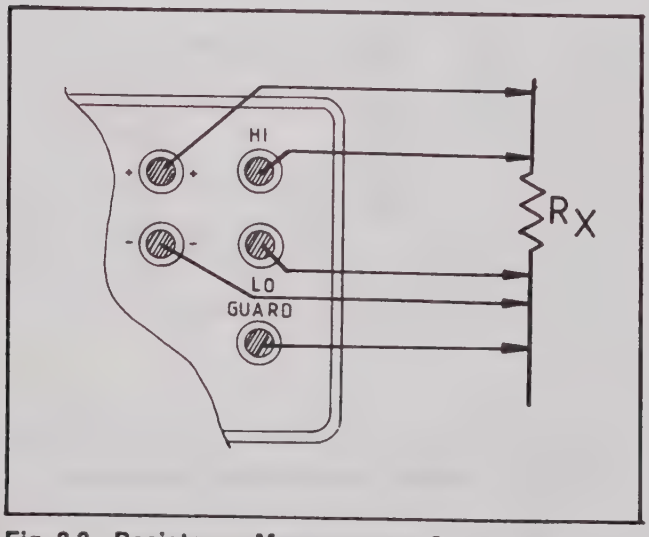


Fig. 3-3. Resistance Measurement Connections.

For Resistance Measurements in noisy environments,
See Figure 3-4 for connections.

3.4.3 Ratio Measurements

The 3600 measures the ratio of the voltage signal at the **HI** and **LO** input terminals to the dc voltage connected at theV_{ref+} and V_{ref-} terminals.**For 3-Wire Ratio Measurements (Basic Model 3600),**

The dc voltage for the denominator of the ratio measurement must be positive, and between 1 and 11 volts.

The **LO** terminal is internally connected to the V_{ref-} terminal.

Select the appropriate measurement mode switch, **ACV** or **DCV**, as determined by the signal connected to the **HI, LO** inputs (numerator of the ratio). The message **Err** will be displayed if the Model 3600 does not have a corresponding AC Option board for the ac input.

Select the appropriate range for the best resolution of the computed and displayed ratio, or autorange.

Read the display. The value is **10 times the actual ratio**, so that the true ratio must be obtained by dividing the displayed result by 10. **(Move the displayed decimal point one place to the left.)**

For 4-Wire Ratio Measurements (Hi-Z Option installed)

Model 3600 configures the inputs for a true differential, high input impedance measurement. Restraints on the voltages are less than for 3-wire configurations:

The reference signal (denominator) must be such that V_{ref+} is 1 to 11 volts more positive than V_{ref-}. V_{ref+} and V_{ref-} must be within 12 volts of the voltage connected to **LO**.

Make mode and range selections as for 3-wire operation, above.

Interpret display value as above.

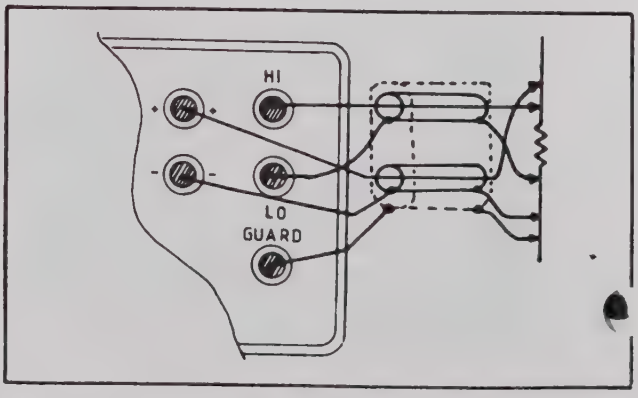


Fig. 3-4. Resistance Measurement in Noisy Environments.

3.5 REMOTE INTERFACE OPTIONS

3.5.1 IEEE488 Setup

The 488 Option Board is delivered from the factory set up for **Address 22** and for operation in the **Talk and Listen** modes. Refer to paragraph 2.8 for device-dependent commands (**Talk**) and output strings ((**Listen**). The address bits may be changed on the option board by suitable setting of the segments of switch S1 on that board. Refer to the table below for code translation when resetting these switch positions.

To use the **talk only** mode, install Jumper W1 and W2 on the option board. Jumper W2 grounds the 488 shield.

Note: When the Model 3600 is programmed to **talk only** on the IEEE488 bus, the 3600 is the controller, and it sends its data when available. It does not respond to any control command when in this mode.

Table 3-2
IEEE488 BUS ADDRESS CODES

ASCII Code Character		Binary Code *					Decimal Code
Listen Address	Talk Address	S1-5 b5	S1-4 b4	S1-3 b3	S1-2 b2	S1-1 b1	
SP	@	0	0	0	0	0	0
!	a	0	0	0	0	1	1
"	B	0	0	0	1	0	2
#	C	0	0	0	1	1	3
$	D	0	0	1	0	0	4
%	E	0	0	1	0	1	5
&	F	0	0	1	1	0	6
'	G	0	0	1	1	1	7
(	H	0	1	0	0	0	8
)	I	0	1	0	0	1	9
*	K	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	0	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
0	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	\	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	^	1	1	1	1	0	30

*NOTE: Only the first five bits of the binary code are given, and these bits are the same for both listen and talk addresses. The sixth and seventh bits determine whether address is listen (01) or talk (10).
Off = 0; On = 1.

3.5.2 REMOTE PROGRAM/DATA (BCD) Option

Prepare a multiconductor cable with the required active lines according to the tables below. Refer to paragraph 2.9 for logic compatibility and for connector type.

Table 3-3
REMOTE PROGRAM/DATA TERMINALS

Pin	Function	Type
X	$\overline{.2V}$, $\overline{.2k\Omega}$	Range Inputs
H	$\overline{2V}$, $\overline{2k\Omega}$	
B	$\overline{20V}$, $\overline{20k\Omega}$	
T	$\overline{200V}$, $\overline{200k\Omega}$	
11	$\overline{2000V}$, $\overline{2000k\Omega}$	
6	$\overline{20{,}000k\Omega}$	
J	$\overline{\text{HOLD INTERNAL TRIGGER}}$	Trigger Inputs
21	$\overline{\text{TRIGGER}}$	
K	INTEGRATE UNKNOWN	Status Outputs
L	READY (To be triggered)	
W	CONVERTING (EOC = $\overline{\text{L}}$)	
14	DATA VALID (New Data = $\overline{\text{L}}$)	
12	$\overline{.2V}$, $\overline{.2k\Omega}$	Range Outputs
13	$\overline{2V}$, $\overline{2k\Omega}$	
U	$\overline{20V}$, $\overline{20k\Omega}$	
V	$\overline{200V}$, $\overline{200k\Omega}$	
Z	$\overline{2000V}$, $\overline{2000k\Omega}$	
22	$\overline{20{,}000k\Omega}$	
5	1	Data Outputs
4	2	
3	4	
2	8	
10	10	
9	20	
8	40	
7	80	
S	100	
R	200	
P	400	
N	800	
F	1000	
E	2000	
D	4000	
C	8000	
18	10,000	
17	20,000	
16	40,000	
15	80,000	
19	100,000	
20	$\overline{+\text{ Sign}}$	
Y	$\overline{\text{OUT-OF-RANGE}}$	
M	$\overline{\text{SIGN NOT VALID (AC or k}\Omega\text{)}}$	
1,A	GND (Wired to Earth via Line Cord)	

Notes: Range inputs are internally wired in parallel with the front-panel switches. For example, if front panel has selected 20V range, the 20V/ Range input will be internally shorted to ground (GND).

INTEGRATE UNKNOWN indicates that the input is being sampled. When INTEGRATE UNKNOWN goes low (False), the input connections may be removed.

Chapter 4
CALIBRATION

4.1 SCOPE

Chapter 4 contains instructions for calibrating Model 3600 DMM, including those instructions for any of installed option boards. The procedures described in the remaining paragraphs of this chapter should be followed in the sequence presented. Omit the procedures for any option card not part of the Model 3600 configuration.

Calibrating adjustments are referenced by their assembly and component reference symbol. See Figure 4-1 for an assembly layout orientation.

4.2 BASIC INSTRUMENT CALIBRATION

4.2.1 Equipment Required,

DC Voltage Source; accuracy ± 20ppm.
Data Precision Model 8200 or equivalent.

4.2.2 DCV Measurement Calibration Procedure

Select **DCV, AUTORANGE.**

Connect the variable input from the voltage standard to the input terminals **HI** and **LO**, and adjust the specified calibrating potentiometer until the Model 3600 displayed measurement is exactly the input value (full 5½-digit conformity).

Table 4-1
Basic Model 3600 Calibrating Adjustments

Input	Adjustment
SHORT (0)	A1R35
– 1.50000V	A1R45
+ 1.50000V	A1R38
+ 0.150000V	A4R7
+ 15.0000V*	A1R28
+ 150.000V	A1R46

*Other voltages near full scale (+ 10V to 17V) may be used for A1R28 adjustment.

4.2.3 3-WIRE RATIO Calibration Procedure

Connect a near-full scale (+ 8 to + 11 volts) signal to both **HI** and **LO**, and to **I+** and **I–**.

Select **DCV, RATIO, AUTORANGE**

Adjust A9R1 to read + 10.0000.

4.3 KΩ OPTION CALIBRATION

4.3.1 Equipment Required

A set of standard resistances whose value is known to within 20ppm.

4.3.2 Procedure

Select **KΩ, AUTORANGE**

Connect standard resistances of values shown in the table below to the Model 3600, using connection diagram for 4-wire measurements shown in Chapter 3, and adjust the specified potentiometers until the displayed measurement value is exactly that of the known standards. The resistance values in the table are nominals; other values near full scale may be used; use the exact values when making the adjustments.

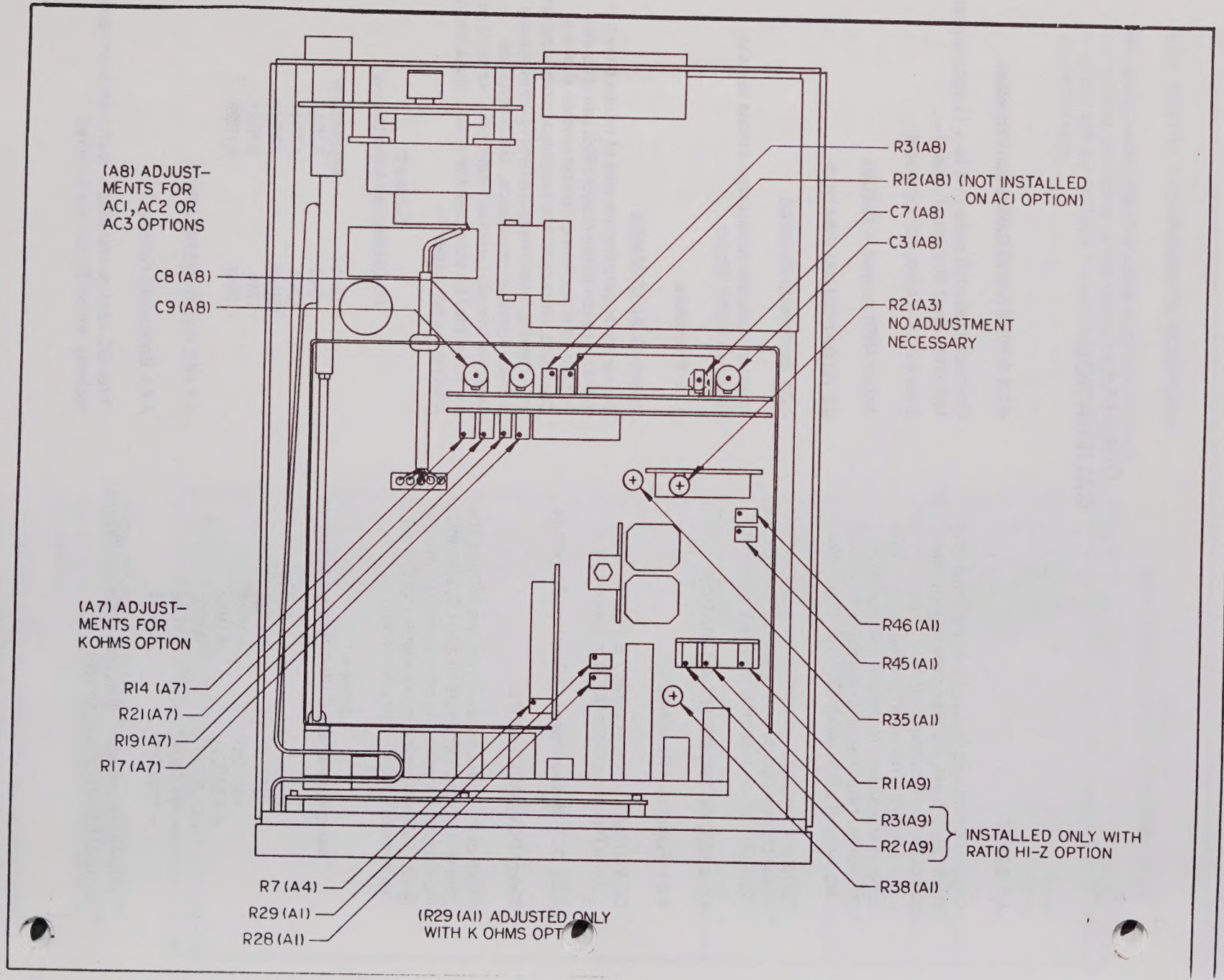
Table 4-2
kΩ Calibrating Adjustments

Input	Adjustment
1.5kΩ	A7R14
15kΩ	A7R17
150kΩ	A7R19
1MΩ	A7R21
10MΩ	A1R29

4.4 HI-Z RATIO CALIBRATION

4.4.1 Equipment Required

Three DC voltage standards, each with short term stability within 20ppm are required.


(A8) ADJUST-
MENTS FOR
AC1, AC2 OR
AC3 OPTIONS
C8 (A8)
C9 (A8)
R3 (A8)
R12 (A8) (NOT INSTALLED
ON AC1 OPTION)
C7 (A8)
C3 (A8)
R2 (A3)
NO ADJUSTMENT
NECESSARY
(A7) ADJUST-
MENTS FOR
KOHMS OPTION
R14 (A7)
R21 (A7)
R19 (A7)
R17 (A7)
R46 (A1)
R45 (A1)
R35 (A1)
R1 (A9)
R3 (A9)
R2 (A9)
INSTALLED ONLY WITH
RATIO HI-Z OPTION
R38 (A1)
R7 (A4)
R29 (A1)
R28 (A1)
(R29 (A1) ADJUSTED ONLY
WITH K OHMS OPT

4.4.2 Procedure

Connect one of the standards as shown in Figure 4-2.

Select **DCV, RATIO, AUTORANGE.**

Set input to values shown in the table and adjust the specified potentiometer for the readings shown.

Repeat the calibrating steps above until no further adjustment is needed.

Table 4-3
HI-Z RATIO Calibrating Adjustments

Setting	Adjustment	Reading
+ 1V	A9R2	9.9990 to 10.0010
+ 10V	A9R1	+ 10.0000

Make connections as shown in Figure 4-2 (3 standards).

Set standards to + 7 volts.

Set Common Mode Source alternately to – 5V and + 5V, while adjusting A9R3 for minimum change in reading, around 10 volts.

4.5 ACV CALIBRATION

4.5.1 Equipment Required

An AC Voltage Standard, with 0.02% accuracy at 100Hz, and 0.1% accuracy afrom 10kHz to 50kHz.

4.5.2 Model 3600 Setup

For any one of the three AC Options, the same front-panel controls are set up. Select **ACV, AUTORANGE** at the Model 3600 front panel.

4.5.3 Procedure

Examine the rear panel label to determine the AC Option installed in your Model 3600.

Refer to the appropriate table of the three below, and perform the indicated adjustments until the displayed reading is exactly equal to the input value.

Table 4-4
AC1 OPTION Calibrating Adjustments

Input	Adjustment
15.0000V, 100Hz	A8R3
500.00V, 20kHz	A8C3
150.000V, 50kHz	A8C9
15.0000V, 50kHz	A8C8
1.50000V, 50kHz	A8C7

Table 4-5
AC2 OPTION Calibrating Adjustments

Input	Adjustment
0.01000V, 100Hz	A8R12
15.0000V, 100Hz	A8R3
500.00V, 20kHz	A8C3
150.000V, 50kHz	A8C9
15.0000V, 50kHz	A8C8
1.50000V, 50kHz	A8C7

Table 4-6
AC3 OPTION Calibrating Adjustments

Input	Adjustment
0.01000V, 100Hz	A8R12
15.0000V, 100Hz	A8R3
800.00V, 10kHz	A8C3
150.000V, 10kHz	A8C9
15.0000V, 10kHz	A8C8
1.50000V, 10kHz	A8C7

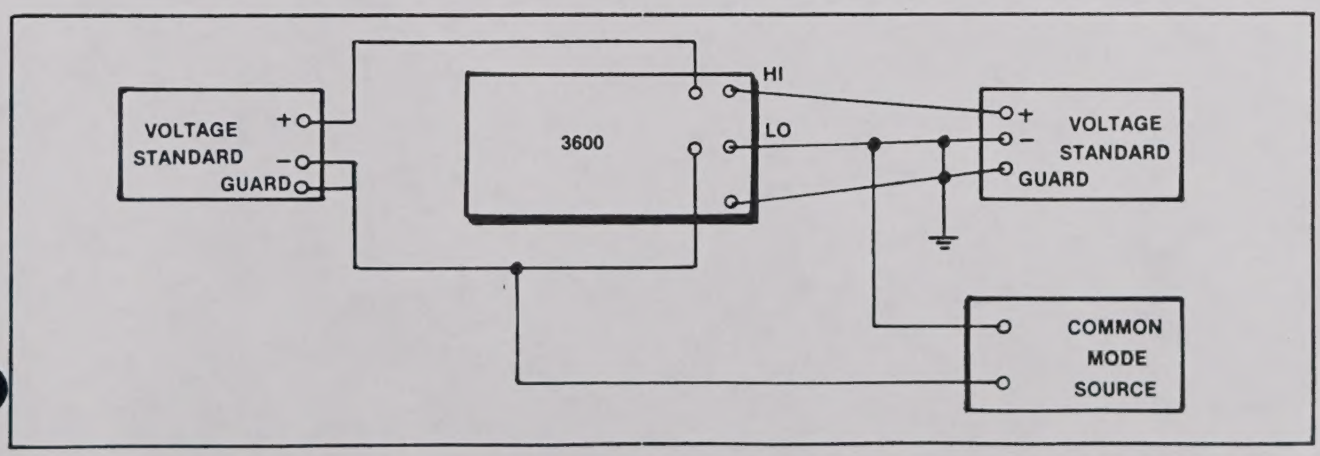


Fig. 4-2. Setup for Calibration of RATIO and HI-Z RATIO.